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R&D
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ABOUT THE COVER Firefighter's helment molded from blend of polyetherimide and polycarbonate meets new 1992 safety standard for impact and fire retardance. *Photo: GE Plastics*

R&D

The International Magazine of Research and Development

FEATURES

MATERIALS

Polyimides: Hot Stuff For the '90s 30

Improvements in both thermoset and thermoplastic polyimides are making them even better for high-temperature applications.

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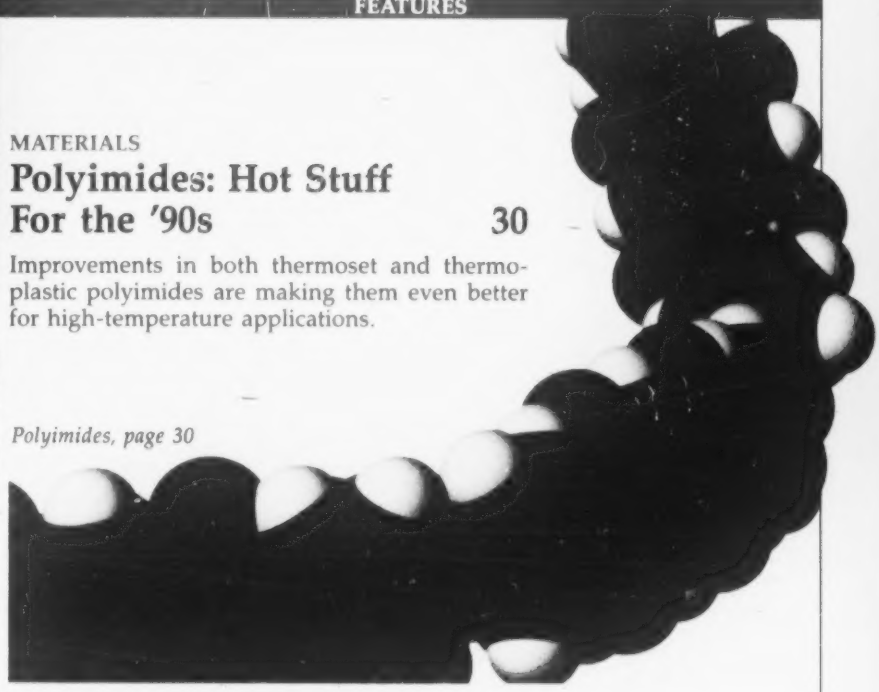

ENVIRONMENTAL RESEARCH

High-Tech Windmills' Future Burns Bright 36

Modern windmill design blends materials science, turbulence theory, and aerodynamic engineering. It's not simple, but it *is* turning on more and more light bulbs.

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Cryo Regeneration Times Keep Getting Shorter 47

Cryopump makers and users alike are resorting to a variety of techniques to reduce regeneration time to under three hours.

COMING IN SEPTEMBER Envisioning your electronic test system . . . *R&D's* Scientist of the Year . . . Selecting the dry pump that's right for your application.

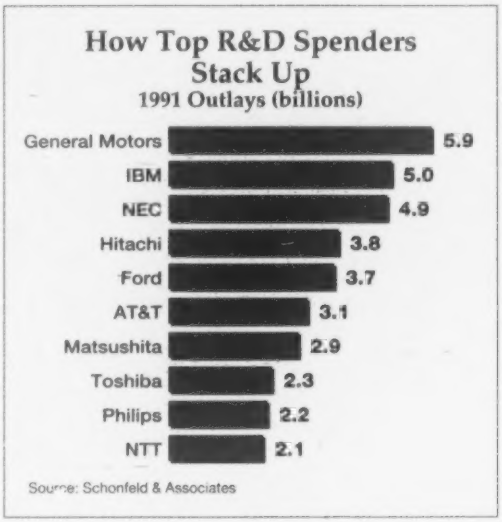
R&D BUSINESS

R&D's Spending Elite Hold Their Own

The biggest R&D spenders continued their hold on the top spots in 1991 with only minor shuffling of positions from the spots they held in 1990, according to a recent study by Schonfeld & Associates, Lincolnshire, IL. In fact, nine of 1991's top 10 spenders have been there for the past five years.

However, Schonfeld predicts continued incursions into U.S. top positions by foreign companies. Japan's NEC is expected to outspend IBM in 1993 by almost $100 million.

For a copy of *R&D Ratios & Budgets*, ($325), call 708/948-8080. □



Japanese Science City Inspires Imitator

The success of Japan's Tsukuba Science City near Tokyo has led civic leaders in the Osaka area to plan a science city of their own. This development, Kansai Science City, however, is expanding upon Tsukuba's focus by including organizations that are involved in researching culture, economics, and the arts.

The centerpiece of Kansai's interdisciplinary approach is the International Institute for Advanced Studies. Modeled on Princeton (NJ) Univ.'s Institute for Advanced Studies, Kansai's institute plans to have research programs in the natural and social sciences and humanities. The Kansai institute has an endowment of about $40 million, and its research-residential complex is scheduled for completion in early 1993.

Kansai Science City is about halfway between Osaka and Tokyo, adjacent to the ancient city of Nara. About 30 facilities are already operating at Kansai, with several hundred more expected early in the next century. Total investment is expected to be more than $30 billion. Initial investments have come from a mixture of public and private sources.

Tsukuba's first research institute was completed 24 years ago. Tsukuba now has 58 government-affiliated research facilities which employ about 10,000 researchers. These labs receive about half of the funding the Japanese government has budgeted for national research facilities.

There also are 168 private research centers involving 221 industrial organizations within Tsukuba Science City and still more in the surrounding area. Of Japan's 47 prefectures, 17 maintain liason offices in Tsukuba.

—Dennis Normile

Reports Give Info On Foreign Research

Who would you contact to find out about metallurgical research in China? You might try Zhou Rong Chang at the Jiangsu Metallurgy Research Institute in Ganjian. But, if you didn't know that very specific bit of information, you might have some trouble determining where to go.

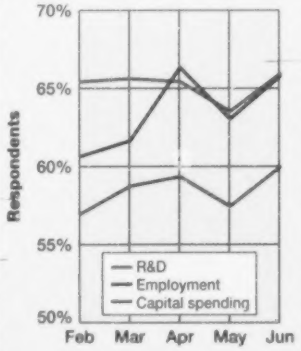
Two recently published management guides to foreign technology can help you with this type of information, along with other foreign research opportunities. These reports include sections on foreign publications, cultural guidelines, and how to set up foreign marketing strategies. They also contain directories of foreign businesses and technology centers and associations, what they do, and who to contact.

For a copy of *How to Find and Exploit International Technology Opportunities—Volume 1/Europe*, or *—Volume 2/Asia, Pacific Rim* ($585 each), call Technical Insights Inc. at (201) 568-4744. **Circle 377**

Moderate Rheology Growth

The market for viscometers and rheometers in R&D and quality functions is forecast to grow about 8% annually to more than $180 million in 1996, according to Strategic Directions Intl., a Los Angeles-based consulting firm.

Sales growth of rheometers is expected to be twice that of viscometers, which is attributed to the increasing sophistication of rheometer features and capabilities.



R&D Rebounds

Following a slight dip in May, corporate confidence in R&D, employment, and capital spending rebounded in June to record high levels, according to a survey by Cahners Economics, Newton, MA.

Almost 68% of the 400 corporate executives indicated that they would maintain or increase their R&D efforts over the next several months.

New CE Applications Deliver Sweet Separations

Capillary electrophoresis is making great strides in solving longstanding problems, from identifying food additives to detecting herbicides.

By *Howard J. Goldner, Associate Editor,* R&D Magazine

R&D

For the past decade, capillary electrophoresis (CE) applications have focused primarily on protein, peptide, and amino acid analysis, with little work being conducted on smaller molecules outside the biochemical area.

Now, however, thanks to lively scientific conferences, such as HPCE '92 held recently in Amsterdam, Netherlands, a wide variety of additional uses for CE are becoming known. As a result, this convenient analytical technique is beginning to find its way into many new industrial surroundings.

At HPCE '92, scientists from the Hershey Foods Technical Center, Hershey, PA, presented many examples of their use of CE in the analysis of food. Several of these have the potential of becoming routine quality control procedures.

Among the CE-based test methods they discussed were the determination of glycyrrhizic acid in licorice root extract, analysis of cocoa for caffeine and theobromine, the determination of vitamin C in citrus and other fruit beverages, and the measurement of niacin in peanut butter extract.

Using a prepared standard, they also demonstrated the feasibility of separating the mycotoxin sterigmatocystin, a potential carcinogenic precursor. In a similar way, they readily separated a mixture of several water-soluble vitamins, including niacin, thiamine, riboflavin, vitamins C, B-6, B-12, and folic acid.

Further studies led to more exciting breakthroughs. "The separation of seven commonly occurring food ingredients—caffeine, theobromine, vanillin, ethyl vanillin, aspartame, sorbate, and benzoate—in a single run is truly remarkable," says W. Jeffrey Hurst, Hershey Foods' senior staff scientist.

"CE is especially advantageous because it allows a rapid changeover from one component type to another," continues Hurst. "Not seen with many other analytical techniques, this feature allows the serial determination of different components in different samples without the need to switch columns or buffer systems.

"These CE methods are faster, easier, and at least as sensitive as what we have in place now. This capability allows the analyst to respond to production and consumer concerns in a timely and efficient manner. CE has excellent potential for the food analyst," notes Hurst.

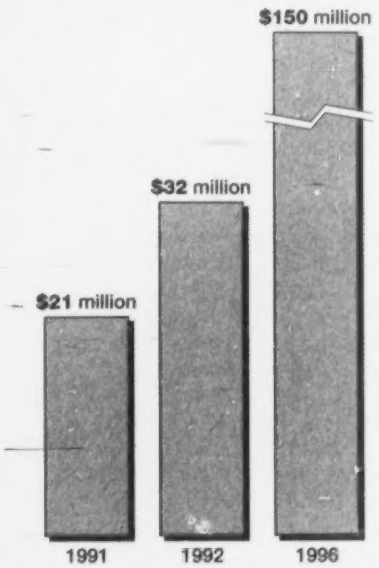
On a different front, agrochemical scientists are beginning to use CE for the analysis of pesticides. Although many methods currently exist for the analysis of pesticides in raw agricultural commodities and environmental samples, most of these use gas chromatography or HPLC coupled with a variety of detectors.

Recognizing the need for rapid and sensitive methods for herbicide analysis, researchers at the Laboratory of Instrumental Analysis, Eindhoven Univ. of Technology, Netherlands, have developed a technique to separate the toxic chlorophenoxy acid herbicides by micellar electrokinetic capillary chromatogrpahy (MECC).

This research team, led by Quanji Wu, was able to easily separate a mixture of 10 chlorophenoxy acids within 10 min. They also found that selectivity could be fine-tuned by using different combinations of surfactants to achieve even greater separations.

The MECC approach avoids the extensive preparation of surface water,

CE Annual Sales Expected To Grow 48%



Source: Strategic Directions Intl.

New uses for CE should prompt a substantial rise in instrument sales.

urine, soil, or sediment samples which HPLC analysis of herbicides usually requires.

U.S. federal and state regulatory agencies now require industry and agrochemical manufacturers to develop suitable methods to monitor their pesticide materials as they are commercialized.

Relatively new among these products is an environmentally safe class of herbicides known as imidazolinones.

Scientists at American Cyanamid Co., Princeton, NJ, have recently begun using CE in the analysis of agricultural and environmental samples for these imidazolinone herbicides, and have obtained results that compare closely with traditional analytical methods such as GC and HPLC.

Moreover, the CE technique is especially attractive since it avoids the use of organic solvents and their associated disposal problems.

These imidazolinones kill plants by inhibiting acetohydroxyacid synthase (AHAS), an enzyme common to the biosynthetic pathway of the branched-chain amino acids valine, leucine, and isoleucine. This inhibition disrupts protein synthesis, which, in turn, interferes with DNA synthesis and cell growth.

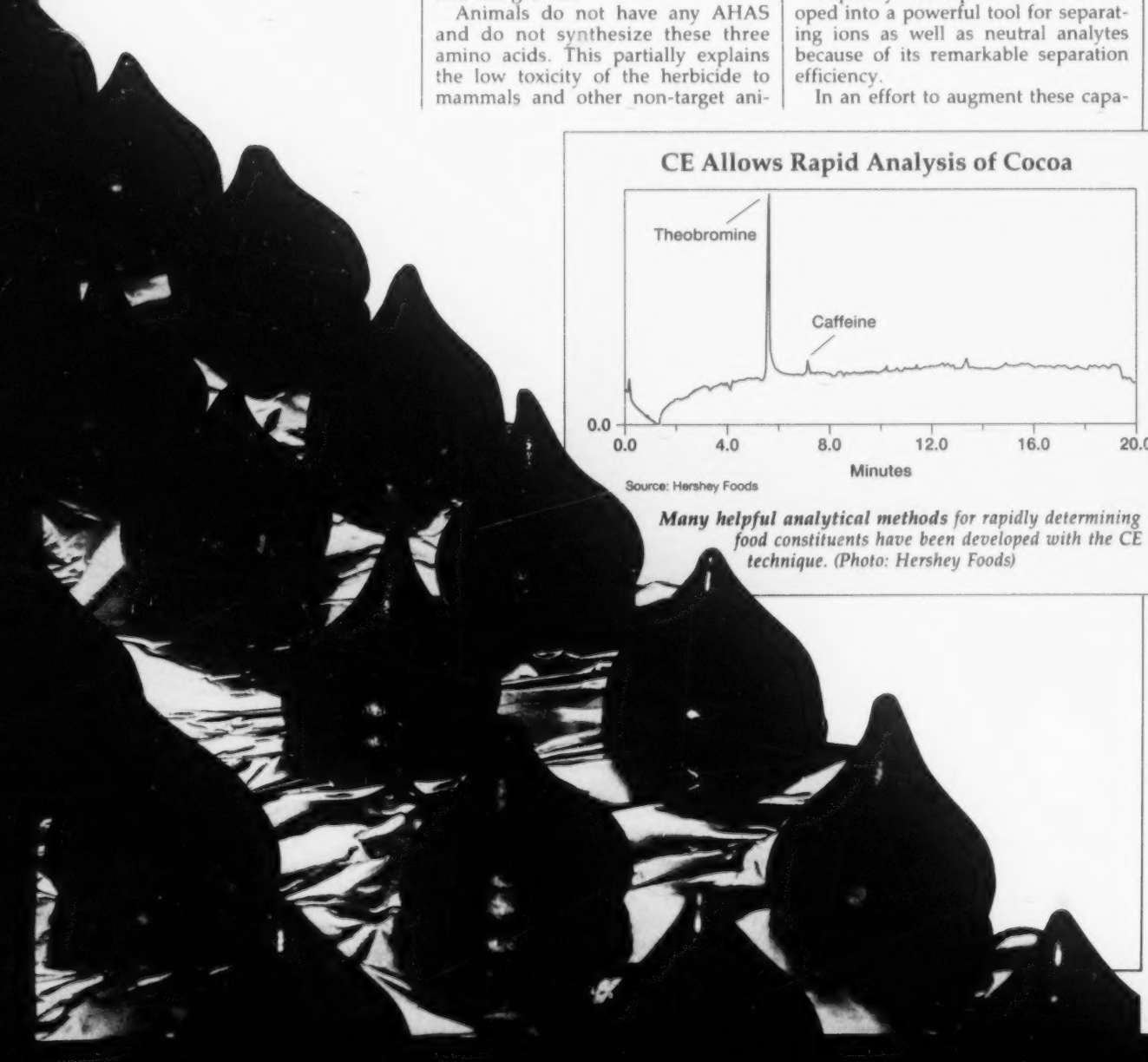
Animals do not have any AHAS and do not synthesize these three amino acids. This partially explains the low toxicity of the herbicide to mammals and other non-target animal species in the environment.

Since imidazolinones and their metabolites may remain in soil, water, and crop commodities, manufacturers are required to have assay methods available for residue detection.

"CE yields high resolution separations of these herbicides in crop samples within minutes, using only nanoliter sample volumes," says Max Safarpour, a research chemist at American Cyanamid. "Because extensive sample cleanup procedures are minimized as compared to other techniques, I expect CE to become a valuable tool for residue chemists in the near future."

Capillary electrophoresis has developed into a powerful tool for separating ions as well as neutral analytes because of its remarkable separation efficiency.

In an effort to augment these capa-



CE Allows Rapid Analysis of Cocoa

Source: Hershey Foods

***Many helpful analytical methods** for rapidly determining food constituents have been developed with the CE technique. (Photo: Hershey Foods)*

'CE is faster and more sensitive than anything we have now. It has excellent potential for the food analyst,' says an industry expert.

bilities, researchers at Millipore, Milford, MA, have recently developed a new technique that combines HPCE and membrane technology. The system recovers the separated species for further analysis. This is in contrast to normal practice, which is to simply discharge the analytes into a reservoir.

Previous attempts to collect these CE fractions have included using small vials to sequentially capture the eluted species, but this technique proved unsuccessful. It generally resulted in significant sample dilution or was too difficult to obtain closely spaced sample bands in separate vials.

Another approach to collecting eluted fractions is to carefully construct an on-column frit near the exit end of the capillary. The electric circuit is then completed through this frit.

This method minimizes the dilution effect. However, it is difficult and time consuming to make the frit, and it functions only when electroosmotic flow is in the right direction.

Millipore's experimental CE fraction collector consists of a membrane assembly placed in contact with the exit end of the capillary. The assembly comprises a polyvinylidene difluoride (PVDF) membrane cover, a buffer reservoir consisting of two layers of 3MM chromatography filter paper, and a stainless steel plate. The plate completes the electrical circuit for electrophoretic separation by acting as the ground electrode.

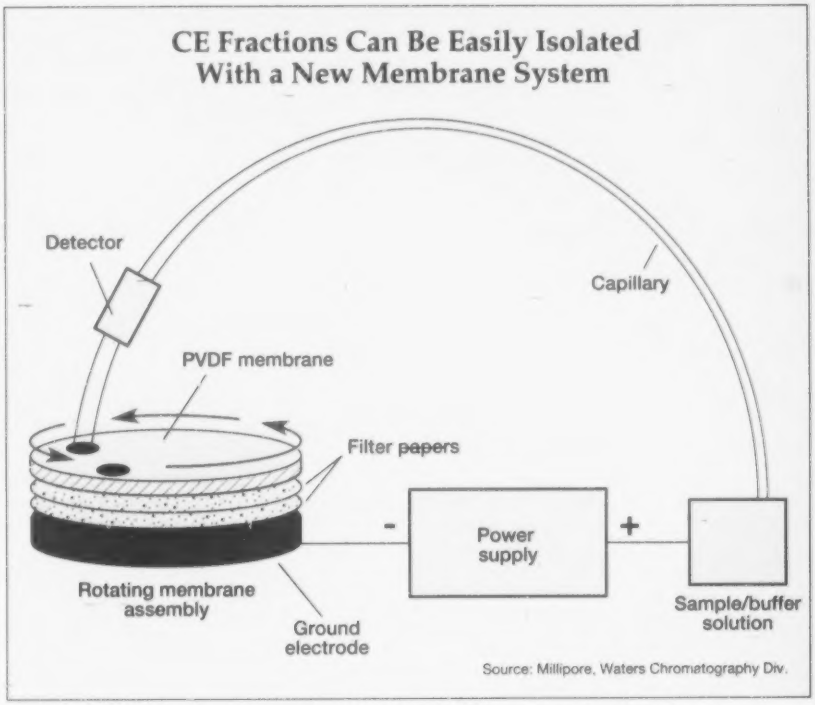
The entire collection assembly is rotated by a stepping motor at 2.2 revolutions per hour while electrophoretic separation takes place. Analytes are deposited onto the membrane at discreet locations as they emerge. The collected fractions can be either stained in place or removed from the membrane for further treatment.

Since the analytes are deposited onto the porous membrane substrate, they are in a form that permits further analysis by a variety of presently available techniques, including staining, immunoassay, ELISA, amino acid sequencing, DNA probes, and chemiluminescence.

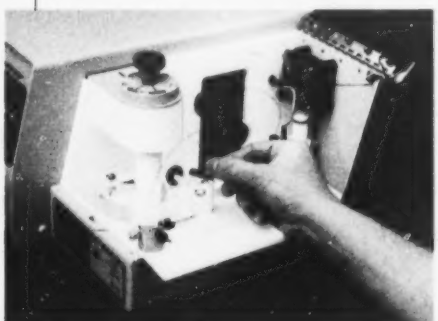
In principle, the membrane can be engineered to trap or bind virtually any species that can be separated by CE to allow these species to be subjected to further analysis.

To demonstrate the feasibility of this technique, the research team performed direct protein sequencing of two recovered proteins following CE separation.

Capillary electrophoresis is moving from a research technology to becoming an accepted analytical tool with a seemingly unlimited range of applications. Methods development is expanding rapidly also as scientists try the technique and quickly discover the many benefits it possesses over existing systems. **R&D**



A new fraction collection system combines HPCE and membrane technology to provide an effective means of obtaining analytes as they are separated and eluted from the capillary, making further treatment of the species possible.



Isco's quick-change capillary holder and three different injection modes allow increased flexibility for many applications.

CE Manufacturers

For more information on capillary electrophoresis equipment and supplies, circle the appropriate numbers on the Reader Service Card.

Applied Biosystems	422
Beckman Instruments	370
Bio-Rad Laboratories	371
Dionex	372
Isco	373
J&W Scientific	423
Spectra-Physics	374
Supelco	375
Unicam Analytical Systems	479
Waters Chromatography, Div. of Millipore	376

Space limitations preclude listing all manufacturers of this equipment. For further information, see the *R&D Magazine* Product Source.

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High **471** Medium **472** Low **473**

R&D SOFTWARE

Processor/Database For Scientific Data

GRAMS/386 runs under Microsoft Windows and can acquire data from hundreds of analytical instruments, streamlining data viewing and processing chores. Data processing capabilities include curvefit, subtraction, quantitative analysis, peak picking, integration, and a variety of chemometric procedures. A three-dimensional, fully relational database offers complete laboratory data management. The database transparently organizes gigabytes of spectroscopic, chromatographic, and other analytical data.
Galactic Industries **Circle 349**

Automatic Line Follower

UnGraph Version 2.0 features an automatic line follower enabling accurate output of X,Y coordinates of graphs and lines. It has an automatic grid removal and compensation for log axes and skewed baselines. Paint and eraser tools enable repairs or interpolations on scans. The single-point digitizer is useful for digitizing scatter diagrams and histograms and identifying height and position of selected peaks of chromatograms, etc. Applications include computer-aided design and the automatic conversion of chart recordings to numbers.
BIOSOFT **Circle 351**

PC/IR Enhancement

Version 3.2 is the company's improved PC/IR program that operates in Microsoft Windows for easy FT-IR operation and improved report generation. Its new features include faster menu speed, Autogain, print preview command, stacked display command, a Cosine Apodization function, and Forman phase correction.
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For information circle **93**

"Wheel! Who needs a wheel!? What we need is a comb!"

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